SEMI-ANNUAL PROGRESS REPORT NO. 14

May 1, 1980 - October 31, 1980

NASA Grant NGL 25-001-054

Submitted To

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Office of Space and Terrestrial Application
Technology Transfer Division
Washington, D. C.

Submitted By

W. Frank Miller*
Bradley D. Carter
Jimmy L. Solomon
Sidney G. Williams
John S. Powers
Jon R. Clark

MISSISSIPPI STATE UNIVERSITY
P. O. Drawer FD
Mississippi State, MS 39762

November 1, 1980

*Program Coordinator

(E81-10078) APPLICATION OF REMOTE SENSING TO STATE AND REGIONAL PROBLEMS Semiannual Progress Report, 1 May - 31 Oct. 1980 (Mississippi State Univ., Mississippi State.) 63 p HC A04/MF A01 CSCL 08B G3/43

N81-13436

Unclas
00078

SEMI-ANNUAL PROGRESS REPORT NO. 14

May 1, 1980 - October 31, 1980

NASA Grant NGL 25-001-054

Submitted To

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Office of Space and Terrestrial Application
Technology Transfer Division
Washington, D. C.

Submitted By

W. Frank Miller*
Bradley D. Carter
Jimmy L. Solomon
Sidney G. Williams
John S. Powers
Jon R. Clark

MISSISSIPPI STATE UNIVERSITY
P. O. Drawer FD
Mississippi State, MS 39762

November 1, 1980

*Program Coordinator

TABLE OF CONTENTS

Page

I. INTRODUCTION-- 1

II. GENERAL PROGRAM PROGRESS-------------------------------------- 2

III. PROJECT PROGRESS REPORTS-------------------------------------- 4

A. REMOTE SENSING APPLICATIONS IN LAND USE PLANNING - LOWNDES COUNTY-------------------------------- 4

Objective-- 4
Accomplishments-- 4
Current Status and Plans-------------------------------- 6

B. APPLICATIONS OF LANDSAT DATA TO STRIP MINE INVENTORY AND RECLAMATION-------------------------------- 7

Objective-- 7
Accomplishments-- 7
Current Status and Future Plans------------------------- 7

C. WHITE-TAILED DEER HABITAT EVALUATION USING LANDSAT DATA-- 8

Introduction-- 8
Objectives-- 8
Accomplishments-- 9
Current Status--11
Future Plans--12

D. REMOTE SENSING DATA ANALYSIS SUPPORT SYSTEMS------------14

Objectives--14
Accomplishments and Current Status----------------------14
Future Plans--16

E. DISCRIMINATION OF UNIQUE FOREST HABITATS IN POTENTIAL LIGNITE AREAS OF MISSISSIPPI-----------------17

Introduction--17
Objectives--18
Accomplishments--18
Current Status--19
Future Plans--19

Page

F. LANDSAT CHANGE DISCRIMINATION IN GRAVEL OPERATIONS------20

Objectives--20
Accomplishments-------------------------------------20
Current Status--------------------------------------20
Future Plans--21

G. ENVIRONMENTAL IMPACT MODELING FOR HIGHWAY CORRIDORS--22

Objective---22
Accomplishments-------------------------------------22
Current Status and Future Plans---------------------22

H. DISCRIMINATION OF FRESHWATER WETLANDS FOR INVENTORY AND MONITORING------------------------------------23

Introduction--23
Objective---23
Methods and Procedures------------------------------24
Current Status--------------------------------------24
Future Plans--24

IV. LIST OF SPECIAL ASSISTANCE OFFERED--------------------26

Information Supplied or Publications Provided----------26
Demonstrations and Educational Activities--------------26
Other Special Assistance-------------------------------27
Facilities---28

APPENDIX I---29
APPENDIX II--34
APPENDIX III---55

SEMI-ANNUAL PROGRESS REPORT NO. 14

May 1, 1980 - October 31, 1980

APPLICATION OF REMOTE SENSING TO STATE AND REGIONAL PROBLEMS

I. INTRODUCTION

The major purpose of the Remote Sensing Applications Program is to interact with units of local, state, and federal government and to utilize Landsat data to develop methodology and provide data which will be used in a fashion such that a concrete, specific action will be taken by the cooperating agency. The attainment of this goal is dependent upon identification of agency problems which are immediate in nature, and subject to at least partial solution through the use of remotely sensed data.

Other subsidiary objectives include the development of a trained staff from the faculty of Mississippi State University who are capable of attacking the varied problems presented by the respective state agencies; the training of students in various University academic courses at both the undergraduate and graduate levels; the dissemination of information and knowledge through workshops, seminars, and short courses; and the development of a center of expertise and an operational laboratory for training and assistance to cooperating agencies.

II. GENERAL PROGRAM PROGRESS

During the past six months, two areas of activity were notable in their effects' on outside agencies. The Lowndes County Civil Defense Director, Mr. Gildea, was active in model development, and use in his various activities. He has distributed photographs of various models to officials in the Federal Emergency Management Agency, the National Weather Service (NOAA), and presented a poster board session at the National Hazards Research Workshop. As a result of these activities, the Regional Hydrologist of NOAA agreed to provide funding to upgrade the Lowndes County Information System to include river vertical stage heights. This will permit the modeling and display of river stage frequency relationships in the county.

As a result of activities associated with the White-Tailed Deer Habitat project, several outcomes have occurred:

1). The Mississippi Department of Wildlife Conservation has funded aerial coverage of the Pascagoula Game Management Area in what is, hopefully, the first step in the application of a Landsat-based information system to state-wide wildlife management on state-owned lands;

2) The U. S. Fish and Wildlife Service's Cooperative Unit, located at Mississippi State University, has funded a project to develop software and methodology to develop a geo-information system which will accept telemetered movement data on wildlife species, specifically deer, but with provision for other game or non-game species.

Excellent progress has also been made on the Unique Forest Habitat project. Of the 54 sites identified by Program personnel as having a high potential for unique biological communities, 31 have been visited by the three botanists and 17 of the 31 contained rare and endangered plant species.

Unavailability of Landsat data of acceptable quality since Fall, 1979 has caused two projects to become inactive. The Gravel project and the Strip Mine project require digital data of recent vintage.

Software development and documentations has progressed rapidly, and the use of an algorithm to develop an expression of entrophy and redundancy has a great deal of promise as additional means of spatial classifications.

III. PROJECT PROGRESS REPORTS

A. Remote Sensing Applications in Land Use Planning-Lowndes County

Objective

To develop a Landsat-based data management system that will provide variables and data which can be used by the County Tax Assessor, the Civil Defense Director, and the Lowndes County Board of Supervisors, and for employment in the land use planning function by the Golden Triangle Planning and Development District and the Mississippi Research and Development Center.

Accomplishments

The Columbus-Lowndes Civil Defense Council, utilizing the Lowndes County Information System, has continued to develop applications consistent with its program goals. During the past six months, over two dozen new models have been generated. The bulk of these are being used to create a comprehensive hazard vulnerability rating system for the county land areas.

Models utilizing Landsat data and other variables include:

1. Transportation hazard models.
2. Fire hazard models.
3. Forest fire hazard models.
4. Air crash hazard models.
5. Flood hazard models.

Some of these hazards have previously modeled using less exacting criteria. The air crash hazard model has been shared with units at the

Columbus Air Force Base, and data for this activity was supplied primarily by the US Air Force and the Federal Aviation Administration.

Photographs and slides of models developed for Civil Defense have been reproduced and distributed to interested officials in the Federal Emergency Management Agency (FEMA) and the National Weather Service/National Oceanic and Atmospheric Administration (NWS/NOAA). A photographic display including computer output was displayed at the National Hazards Research Workshop in Boulder, Colorado in July; the City of Columbus and Lowndes County were represented by the Civil Defense Director. The title of his presentation was: Hazard Prone Areas-Computer Models.

The Columbus-Lowndes Civil Defense Director wrote two grant proposals related to the application of MSU Program activiites: A Pilot Project to Develop a Geo-Base For Evacuation Planning in the Vicinity of the Grand Gulf Nuclear Power Plant, and A Proposal to Implement Automated Approaches to Local Flood Warning and Mitigation. Both projects are currently under consideration at the national level as special pilot activities, and both involve the direct application of geo-base information for emergency management planning and response. The former would create a new geo-base for use in developing radiological emergency response plans for a fixed nuclear facility in Mississippi. The data base would enable the Mississippi Emergency Management Agency, responsible for nuclear contingency planning, to meet or exceed many of the program elements identified in the Nuclear Regulatory Commission (NRC)/ FEMA standards: NUREG-D654; FEMA-REP-1. The latter application will utilize existing Lowndes County data base output in conjunction with the Civil Defense micro-computer system to provide detailed information concerning residences and facilities located in identified flood-prone areas.

In September, the Civil Defense Director gave a detailed brief to the NOAA/NWS Regional Hydrologist Mr. C. E. Vicroy, Jr.. Mr. Vicroy recognized the value of the system in transforming vertical stage heights to highly defined impact areas, and has agreed to make Regional resources available, including on-site assistance for high-level staff members, to aid locally in refining our use of the system by introducing hydrologic parameters. By doing so, stage/frequency relationships may be visually displayed for planning purposes.

Early in October an article outlining the utilization of the Remote Sensing Applications Program data base was published on the National Association of Counties quarterly news publication; the article was featured in a special emergency management supplement (Appendix I). At least three other national publications have expressed a tentative interest in similar articles.

Current Status and Plans

The Civil Defense Office is also assisting the Remote Sensing Applications Program in conducting a half-day workshop for local officials and interested residents to identify possible sites suitable for a hazardous waste disposal site. Both those who favor such a site, as well as those who are opposed, will hopefully work together to develop objective models for further investigation.

B. Applications of Landsat Data to Strip Mine Inventory and Reclamation

Objective

The objective of this project is to provide the Alabama Surface Mining Reclamation Commission and the Geological Survey of Alabama with the software and interpretative techniques for monitoring strip mine occurrence and reclamation activities. The results will also be provided to the Mississippi Geological, Economic, and Topographic Survey - the State agency which is responsible for administering the surface mining law in Mississippi.

Accomplishments

Efforts to secure a CCT with which to test the validity of the March 15, 1979 data have not been successful; the evaluation of temporal extendability of Decision-Tree Classifier must await acquisition of the new CCT.

Current Status and Future Plans

This project will remain inactive until data acquisition. A test of temporal extension will then be performed.

C. White-Tailed Deer Habitat Evaluation Using Landsat Data

Introduction

In order to provide a basis for sound natural resource manage-ment in Mississippi, the Mississippi Game and Fish Commission has initiated the development of a State-wide data base system which will be used to describe various components of Mississippi's ecosystems. The high priority of the white-tailed deer (*Odocoelius virginiana*) in the Commission's management policies dictates that various types of deer "habitat" be mapped and evaluated on a Statewide basis. These "habitats" will be delineated on the basis of several biophysical variables.

Because of its synoptic and temporal characteristics, Landsat multi-spectral scanner (MSS) data will be used as the basis for vegetative evaluation. Both supervised and unsupervised classification of the data will be performed to determine the most accurate and the most cost-effective means of mapping vegetation. Other variables used to evaluate deer habitat will be compiled from existing sources. All data will be configured in a computer-assisted data base to facilitate rapid and accurate habitat evaluation.

Objectives

The project's objectives, in order of planned completion, are:

1. To determine those types of vegetative associations which are of significance in managing Mississippi's white-tailed deer.
2. To determine which of several analytical procedures are most effective in detecting these vegetation types using Landsat MSS data.

3. To configure this vegetation data, as well as other data pertinent for habitat evaluation, in a computer-assisted data base which will permit habitat description and evaluation.

Accomplishments

The majority of the computer-assisted land cover mapping for the Tallahala, Choctaw, and Leaf River Wildlife Management Areas (WMA) has been completed. The optimal combination of Landsat Multi-spectral Scanner (MSS) data channels, season of data acquisition, and image analysis algorithm has been identified through work embodied in the Master of Science thesis for Jonathan R. Clark. This work concludes that the unsupervised classification of spring MSS data was the simplest and most accurate method of mapping land cover using Landsat digital information. This work was necessarily biased towards forest type mapping and as such was dealing with land cover types of relatively low reflectivity. This posed a unique problem for the unsupervised classification process which is fairly effective at discriminating agricultural and open lands which are more highly reflective, at the cost of pooling the less reflective forest types. The detection of the various forest types of interest to this study was accomplished with moderate success by creating the maximum number of spectral classes possible from the spring MSS digital data. This allowed the different forest types which occurred statistically close in the MSS data to be separated in the unsupervised classification approach. Forest mapping units of 15 acres or more could consistently be delineated using spring data. The discrimination of species associations (pine, upland hardwoods, bottomland hardwoods, etc.) was adequate, but some problems with differentiating age classes of hardwoods were encountered.

Supervised classification and a decision-tree classification were also attempted but were less successful and much more cumbersome techniques to implement. The "HINDU" unsupervised classifier was not employed based on MSU Computer Science Department's suggestions that it would not be sensitive enough to the subtle differences in reflectivities of the forest types.

The image analysis work to date has resulted in the establishment of the statistical criteria for the image classification for the entirety of the three study areas. The full study-area mapping using Landsat digital data is being performed at present.

The construction of digital, habitat data bases for the three study areas has made up 30 percent of the project effort over the past 6 months. The Tallahala WMA data base is virtually complete with 12 variables configured in the computer files. Data bases for the Choctaw and Leaf River WMA's have been initiated and contain two variables each. Hand drafted map overlays for an additional 4 variables, have been prepared for the latter two data bases and await digitizing. The data base for the Tallahala WMA has also been transferred to the Data General Eclipse minicomputer for interactive habitat evaluation work.

Preliminary habitat evalution models have been run on the Tallahala WMA data base. These models have been developed in consultation with personnel from the MSU Department of Wildlife and Fisheries (DWF). This was done to familiarize DWF personnel with the data base modeling techniques. These models are being evaluated at present and more are being planned.

Current Status

Computer-assisted land cover mapping for the entirety of the three study areas is being performed at present. This work is being based on the results of the thesis work mentioned earlier and should result in the land cover data sets configured in the habitat data bases in late November 1980.

Completion of all three data bases is the main concern of the project at this time. Several hand drafted map overlays are awaiting digitizing and several more are in preparation. All three data bases should be complete in early December 1980. This will make available three habitat data bases from three physiographic provinces. Each data base will consist generally of the following variables:

Political Boundaries
Surface Water Features
Roads, trails, utility rights-of-way
Soils
Elevation
Land Cover
Residential, Commercial, Industrial sites
Prescribed Burning History

The data bases will be configured in the MSU Univac 1100/80 computer for batch model processing and the Data General Eclipse minicomputer for interactive habitat evaluation.

Evaluation of models already run on the Tallahala WMA data base is being conducted in conjunction with the DWF. This will result in the first trained user group for these data bases. These same persons are being trained in the use of the Data General minicomputer for interactive use of the habitat data bases.

Future Plans

All three habitat data bases will be completed by early December 1980. These initial versions of the data bases will be sufficient to allow considerable modeling efforts by DWF and Mississippi Department of Wildlife Conservation (DWC) personnel. Training of (personnel DWF and DWC) in data base use will become more intensive in November 1980 and will allow these users to interrogate the data bases on their own sometime in January 1981.

It is hoped that the habitat information and resultant models will be evaluated throughout the winter of 1980-81 and that field studies to evaluate the models can begin in spring 1981.

Topographic information, especially slope, is critically important in wildlife habitat productivity. The elevation data presently in the data bases only partially satisfies this requirement for topographic information. The acquisition of computer programs which can generate slope and aspect information from elevation data will be a prime concern of the project in the coming months.

One question which remains to be answered about land cover mapping using Landsat MSS data is how far (geographically) beyond a sample area the spectral signatures can be extended without seriously degrading image classification accuracy. This must be answered to permit the state wide land cover mapping required for deer habitat evaluation for the state. The unsupervised approach will be extended out into the physiographic regions where sample pixels have already been examined. Hopefully, an entire physiographic region can be classified accurately based on a minimum of samples within each region. If so, the entire state can be mapped by using stratified samples for each physiographic region.

D. Remote Sensing Data Analysis Support Systems

Objectives

To effectively implement the remote sensing applications and projects of the Applications Program, particularly those involving the Landsat multi-spectral data, it is essential that reasonably sophisticated computer-based data processing and data analysis systems be developed. Considerable effort is required to develop new computer software, to adapt existing software, and to install needed hardware facilities. This is in addition to the operational data processing and data analysis needs of each demonstration project. Moreover, it is the objective of the Data Analysis Support System to provide the data collection and processing capabilities necessary to support the various demonstration projects, and to provide a low-cost operational center so that such projects can have a continuing input into the overall objective of the Applications Program.

Accomplishments and Current Status

A version of the CALUP (Computer-Aided Land Use Planning) program is now available for use on the Data General S 130/Lexidata 6400 image display system. CALUP allows the user to make land-use decisions which are based on variables stored on an S130 disk file. A database for CALUP can consist of up to 40 scenes (called variables), each describing a different attribute of a common geographical area. The different variables are combined (one pixel at a time) in a manner described by the user (i.e., by a model) to form a new scene or image. The new image is immediately loaded into the Lexidata 6400 refresh memory and can be immediately viewed on the Conrac color monitor. The model, which was originally input from the CRT terminal, can be optionally saved on a disk file, which can be used at a later time to reconstruct the scene. The CALUP program will also optionally save the new scene on a disk file. This file can then be used as input to either the CALUP program or any one of several programs presently in existence on the Data General S130.

A utility program is also available for transferring data base that exist on the Univac 1100/80 disk files for use with the Data General version of the CALUP program. The program called DBCONV reads the 1100 database file, which is on bit packed format, converts it to run-length compressed format (used by the S130 CALUP program), and writes the data base to magnetic. The data base is simply transferred to an S130 disk file and it is ready for use by the S130 CALUP program.

An algorithm has been developed by John Powers which performs a primitive feature selection process on Landsat MSS imagery utilizing a nearest-neighbor scanning algorithm. The results of this algorithm are coordinate registered to the parent imagery and are utilized as an extra channel in decision theoric clustering classification routines. This procedure has been applied to the classification of forested areas with very promising results in terms of sub-species definition and eco-zonal delineation, exhibiting markedly superior resolution in existing MSS classification results. The procedure is still in the experimental stages, but is expected to eventually consist of three (3) synthetic channels, including an "edge-effect" channel. These channels would replace MSS channels 1 and 3 in the classification process.

Future Plans

Some of our earlier software is plagued by a number of "bugs" which are primarily causes of extreme user frustration. A concerted effort to "clean-up" these programs is currently underway, and to further develop the feature selection algorithm.

As previously reported, no classifier exists for the Data General computer. All classification of Landsat data is currently being accomplished on the Univac 1100/80 using the LARSYS and HINDU program. Future plans include implementation of such a program on the Data General system. Programs being considered for adaptation are HINDU, ELAS, and AMOEBA.

E. Discrimination of Unique Forest Habitats In Potential Lignite Areas of Mississippi

Introduction

As a result of the current energy demand that our country now faces, lignite coal deposits in Mississippi have recently come under study as a potential source of recoverable fossil fuels. Mississippi has approximately five billion tons of surface minable lignite which is equivalent to ten billion barrels of oil, and ranks second only to Texas among the Gulf Coast states with respect to these lower grade reserves. A "belt" of lignite deposits presently exists in northern and east-central Mississippi, and, with respect to Mississippi topography, surface mining methodologies appear to be the most efficient and economical form of recovery. The belt can be divided into two sections, the first from north of Marks, in Quitman County, through western Panola County into Lafayette County. The second section originates in Lauderdale County, extends into Kemper, Neshoba, Winston, and Choctaw Counties, and ends at Webster County.

Since the surface mining of lignite will undoubtedly have environmental impacts on the local physiography where the extraction occurs, it is imperative that areas of unique or historical ecological habitats within the belt be located, documented, and preserved if possible. One such forest community type under scrutiny is old growth hardwood stand remnants, especially those which have not been seriously affected by agriculture, grazing, timber harvesting, or fire.

Objectives

The objectives of this project are: (1) to develop a cost-effective methodology using Landsat and aircraft data to discriminate areas of old growth hardwoods that do not exhibit signs of recent disturbance within Mississippi's lignite belt, and (2) to identify and map such areas and provide the information to botanists employed by the Mississippi Heritage Program.

Accomplishments

Based on Phase II results, a total of 54 stands were identified as having at least moderate potential as unique biological communities. Twenty-nine sites were field checked after identification, and 25 have not been visited. Of the 31 sites checked by the three botanists, 17 were rated as either containing rare and endangered plants at the time of the visit, or having the potential of having the plants.

The geographic data base for the Natural Heritage Project is nearing completion. The data base now contains 11 variable classes, the eleventh class being ground cover over the study area as determined from computer classification of Landsat data. The major problem encountered in integrating Landsat data in the data base has been the location of exact control points over the predominantly rural zones in the study area. This is being successfully resolved, however, and the maximum root mean square error over the entire data base is less than or equal to 1 for the fifty acre cells. All data bases created at the Center are, without exception, maintained at a RMS error of less than or equal to 1 for their respective cell sizes. All data base creation and maintenance software has been fully optimized, and is running smoothly.

Further alterations in software or storage structure are not anticipated, and final documentation of the system is in progress for possible future dissemination to public and private agencies.

Current Status

The digitized Landsat data is being placed into the data base, and the total study area will be modeled to determine after areas of significance for investigation.

Future Plans

Botanists will visit the remainder of the identified sites in the spring of 1981; in addition, the sites identified by means of the Landsat-based Information System will be supplied to the botanists for investigation.

F. Landsat Change Discrimination in Gravel Operations

Objectives

As stated in the original proposal, the objectives of this investigation was to develop methodology and computer software to effect temporal change detection in gravel operations, and thereby enable acreage estimations of active operations to be calculated at different points in time. Landsat digital data (CCTs) were to be utilized for this change detection beginning with an exposure date of just prior to April 15, 1978. The endpoint analysis was to be on a date during the spring or summer of 1980.

Accomplishments

A complete digital analysis has been accomplished for the Landsat data exposed in March, 1978 through employment of two classification techniques: (1) the EOD/LARSYS software package; and (2), a Decision Tree Classifier algorithm. Thirty-five millimeter slides from field checks and 1/24,000 CIR imagery of some of the areas were used to aid in identifying land cover types. Signatures have been generated for inert materials, water, bare soil, forest, fields, edge effect, and reclamation areas. Acreage estimates for the operations were calculated by use of a color graphic/image display system (S/130 Data General minicomputer) and computer printout maps of the areas. The project is funded by the Mississippi Minerals Resources Institute, and a first phase report has been submitted to them.

Current Status

The completion of this investigation awaits a Landsat satellite pass of sufficient quality (e.g. 10% Cloud Cover, correction of hardware problems on the satellite, etc.) to detect temporal change in active mining. This project is inactive.

Future Plans

Upon receiving adequate satellite coverage of the study area, the data will be analyzed and a supplemental report will be written and submitted to the MMRI for final evaluation.

G. Environmental Impact Modeling for Highway Corridors

Objective

The objective of this small project is to develop a cost-effective, accurate methodology for assessment of environmental impacts of alternative highway corridors.

Accomplishments

A final report has been submitted to the Mississippi Highway Department (Appendix II). The Program Coordinator met with the Highway Design Engineer and presented the results of the study. The Highway Engineer is currently evaluating the feasibility of using the methodology in other highway corridor assessment projects.

Current Status and Future Plans

This project is currently inactive, and will remain so until the Highway Department has an opportunity to assess the project results. In the event that a favorable decision is reached, Program personnel will either

1) train Highway Department personnel in the use of the techniques or
2) provide the services required if the Highway Department does not wish to undertake the expense of hardware purchase.

II. Discrimination of Freshwater Wetlands for Inventory and Monitoring

Introduction

Concern over the destruction of the nation's wetland resources is currently in the forefront of environmental issues. Their value as a protection to other ecosystems has only recently been recognized, as well as their concomitant value in supporting unique plant and animal species themselves. Although many studies have been conducted, laws passed, and classifications systems established, there are still many large gaps in knowledge which need to be filled.

The official wetlands classification system currently being used by U. S. Government installations is the U. S. Fish and Wildlife Service's publication, Classification of Wetlands and Deepwater Habitats of the United States. This system was designed for use on a nationwide basis, and is therefore necessarily very general in character, hence it is of limited value on an area or local scale. The Mobile Corps of Engineer District have expressed a need for, and interest in developing a system that would be more closely correlated to unique local and area conditions (Appendix III).

Objective

The objective of this proposed study is to develop remote sensing techniques, utilizing aerial imagery and satellite data, for delineating freshwater wetland types with increased accuracy, and decreased intensity of on-site inspection.

Methods and Procedure

Okatibbee Reservoir, located in Jasper County, Mississippi, will be used as the model or primary study area, as it is a hardwood bottomland wetland ecosystem typical of the southeastern United States; and due to the presence of the reservoir itself, a number of other wetland ecosystems and subsystems have developed within the area. In addition, aerial imagery and Landsat data are already on hand.

Training sites will be selected on Okatibbee Reservoir that are representative of classifications under the Fish and Wildlife system. These training sites will then be ISOCLAS'ed and the study area classified utilizing Landsat data and the EOD/LARSYS software package. Aerial imagery and field data will provide ground truth for refining the computer classification; i.e., assigning signatures to specific wetland types.

The refined system will then be tested for accuracy and functionality in several different locations using an unsupervised classification method, and the ground truthing by on-site inspection.

Current Status

Ground truth has been collected for Okatibbee and a supplementary study site in Jasper County, Mississippi on the Tallahala River. Manual analysis of 1/24,000 color infrared imagery is 95% completed, and the wetland types transferred to base maps.

Future Plans

Within the next three months, Landsat digital data will be processed using various classification techniques. The various output will be compared with actual wetland types, and modified until a methodology has been established which will yield the maximum amount of data concerning wetlands. Personnel of the Regulatory Functions Branch, Corps of Engineers, Mobile District will be visited to determine their exact requirements prior to the final decision on methodology.

IV. LIST OF SPECIAL ASSISTANCE OFFERED

Information Supplied or Publications Supplied

Dr. Dick Collins, Assistant State Forester, Mississippi Forestry Commission, Jackson, Mississippi

Mr. Richard Yancey, Director, Mississippi Department Wildlife Conservation, Jackson, MS

Mr. Bob Griffin, Mississippi Department of Wildlife Conservation, Mississippi State, Mississippi

Mr. Joe Sigrest, Biologist, U. S. Army Corps of Engineers, Vicksburg, Mississippi

Mr. Don Dale, Region Forest Engineer, Weyerhaeuser, Dierks, Arkansas

Representative W. A. Wilkerson, Lucedale, Mississippi

Public Technology, Inc. Washington, D. C.

Mr. Bill Rule, Crowley's Ridge Aerial Services, Wynne, Arkansas

Mr. Larry Lassen, Director, Southern Forest Experiment Station, New Orleans, Louisiana

Mr. Barton Bennett, Bennett and Peters, Inc., Baton Rouge, Louisiana

T. D. Fortune, Photogrammetirc Engineer, Mississippi Highway Department, Jackson, Mississippi

Demonstration and Educational Activities

Laboratory tours were provided for the following individuals or groups:

Mr. Bill Jones, Member of Board of Trustees of Mississippi Institutions of Higher Education; Public Relation Director of Masonite Corporation

Mr. Bryce Griffis, Member, Board of Trustees; President, Sturgis Lumber Company

Mr. Wayne Mooneyhan, Director NASA/Earth Resources Lab, NSTL

Dr. Arnett Mace, Director, School of Forest Resources, University of Florida, Gainesville, Florida

William Haynes, Technical Service Director, Union Camp Corporation Sarcumah, Georgia

Dr. Dick Portersfield, Technical Division Director, Champion Timberlands, Stanford, Connecticut

Dr. Eldon Ross, Director, SE Forest Experiment Station, U. S. Forest Service, Asheville, North Carolina

State Representative Bruce Hansen, Columbus, Mississippi

Kathy Webb, Chamber of Commerce, Mayor's Office

Larry Tyner, Public Relations, Weyerhaeuser

Francis Jectman, National Bank of Commerce

William Walker, Chief, Mississippi Employment Services

Jack Colbert, Owner, Colbert Real Estate

Stan Murray, National Bank of Commerce

Hyde Powers, Swoop Real Estate

Jim High, President, Seminole Manufacturing

Tony Pierson, Commander of 14th Flight Training Wing

Stanley Hayes, Commercial Dispatch

Eddie Cox, First Columbus National Bank

Steve Cobb, Chief of Environmental Planning Section, Lower Mississippi River Division, U. S. Corps of Engineers

Special displays were presented at the Southern Forest Soils Conference in Vicksburg, Mississippi, and Mr. Ray Gildea presented a poster bound session at the Natural Hazards Research Workshop in Boulder, Colorado.

Other Special Assistance

Working in cooperation with Mr. Richard Yancey, Director of the Mississippi Department of Wildlife Conservation, (DWC) and several of his workers, personnel of the Remote Sensing Program developed flight plans for the various State-owned game management areas. Funding permitted the acquisition of aerial data only on the largest of the areas. The 33,000 acre Pascagoula Management Area. Program personnel are committed to training DWC personnel in data acquisition, and to pursuing the possibility of an update resource technique centering around a Landsat-based information system.

Facilities

The Data General Minicomputer has been purchased from the Mississippi State University Electrical Engineering Department, and the mini and peripherals have been moved to a laboratory room in the Computer Science Department. The mini is now dedicated to the remote sensing effort.

APPENDIX I

By Ray M. Gildea, Director, Columbus-Lowndes Civil Defense Council, September 5, 1980

More and more counties are finding that economic survival depends upon how successful they are in reducing damages caused by natural and manmade disasters.

Lowndes County, Miss., is faced with frequent flooding. Although it is not a large county—about 55,000 people live within 550 square miles—damages from flooding alone have approached $40 million during the last two terms of elective office.

To reduce these damages, Lowndes County used a joint powers agreement with the city of Columbus to expand the scope of the civil defense office from disaster response to hazard mitigation.

This move has required the office to take on some difficult and time-consuming tasks, some of them highly technical in nature.

Planning needs have been documented, the civil defense office was organized, flood studies have been compiled, and data have been collected, stored and analyzed. Land-use regulations are being proposed and public education is ongoing. The whole program relies on local initiative if the county is to realize tangible savings by reducing flood damage.

PLANNING NEEDS DOCUMENTED

Three years ago, a study group of interested county residents prepared a position paper for local officials expressing the need for more aggressive emergency planning programs, especially for flooding. In their report, the group said there was a lack of local initiative in anticipating the impact of potential floods: "... our community is honest and frank when it objects to preparing for a hazard that it does not anticipate will ever happen. Our hazards, on the contrary are very real. Evidence of these hazards is already being gathered by the civil defense office. This evidence must be transmitted in a suitable form to people in a position to do something about them."

After establishing the need for intensive disaster preplanning, especially for flood hazard mitigation, the civil defense office began to gather technical information and translate it into terms laymen could understand. The director's academic background in hydrology and water-related fields helped him to communicate with technical experts involved in collecting, evaluating and disseminating data concerning local rivers and streams.

Through a series of meetings and after writing and receiving hundreds of letters, local residents assisted local government in "retooling" its civil defense staff with the skills needed to analyze flood problems.

The reorganization of the local emergency management office was carried out with three overall goals: to reduce flood damage by implementing both structural (dykes, levees, channelization, etc.) and nonstructural (relocation of homes and businesses, floodproofing, etc.) hazard mitigation activities; to demonstrate ways to use resources, emphasizing low-cost activities using private sector investments and in-kind services; and to show the cost-effectiveness of structural and nonstructural damage reduction activities in a medium sized community, which had average annual damages in excess of $1 million.

After a series of meetings, another citizen action group responsible for project design identified three ways to meet the goals: use previously generated local flood studies to examine alternative mitigation options; create a clearinghouse to store technical and non-technical flood-related data to be used to outline a well balanced program; and motivate local government officials and area residents to implement previously suggested mitigation activities on a high priority basis.

FLOOD STUDIES COMPILED

Over a two year period, pertinant materials were collected from a host of sources. A rich body of locally oriented flood damage reduction materials, prepared by a host of agencies and organizations, already existed. Federal agencies, such as the National Oceanographic and Atmospheric Administration and the U.S. Corps of Engineers, had produced a number of ideas and proposals, in addition to those generated through government contracts by universities and private consultants.

Many of these studies had not been given to local governments or presented to the appropriate groups for action. Occasionally, the civil defense office spent a great deal of time gathering information for a study, but could not obtain copies of the study when it was completed.

Most flood studies had the following limitations: the cost effectiveness of the recommended activities, especially those applying to businessmen, was not indicated; the findings were not released until the crisis had passed, and they were not used to prepare for future floods; the lack of coordination and communication between public agencies and private interest groups involved in the studies resulted in a lack of action; and the general lack of integration or synthesis among all of the studies and the inadequate input from local officials greatly reduced the studies' practical value.

DATA COLLECTED, STORED AND ANALYZED

The collection of field data was the turning point in the flood mitigation program. As technical data and relevant information began pouring in, the need for automated storage and retrieval became evident.

With assistance from several local computer buffs as volunteers, we designed an affordable system using a $3,000 microcomputer. The volunteers, from universities, local business and industry, developed software that could translate flood data programs from other agencies into the language used by our computer. The system has been both accurate and reliable.

The first project was to code flash flood tables generated by the Southeast River Forecast Center (RFC). As soon as the tables required revision, due to additional flood experience, the hydrologists at the RFC helped us write a simple computer program that would derive the tables. This enabled the Civil Defense Office to revise the flood forecast with a minimum of outside assistance. A feeling of self sufficiency grew from this endeavor and seemed to carry over into our other warning activities. We discovered that the more a county was directly involved in the interpretation of flood-related information, the more likely it was to use the information, not only in actual flood situations but also in promoting damage reduction efforts before the floods occurred.

While the microcomputer project was getting underway, another group of volunteers sought a systematic way to analyze and display probable flood-prone areas under a wide variety of possible conditions. This called for an even more flexible tool than the microcomputer. With the assistance of the Remote Sensing Applications Center at Mississippi State University, a system was devised to display the county on a minicomputer, using 67,000 five-acre cells as the storage units for the data. This system enabled the Civil Defense Office to provide accurate warnings on two hurricanes, Bob and David, in 1978.

The system has also been used to analyze problems associated with FIA flood plain maps. These maps did not address some 50,000 acres of county land area, a large portion of which is undergoing extensive development. The minicomputer delineated the flood-prone lands in these tracts. The resulting projections represent the only official attempt to identify the flood-prone areas left unstudied by FIA.

Perhaps the most significant application of this minicomputer system for flood hazard analysis is in the projection of suitable sites for industrial, commercial and residential development located outside flood-prone areas. Putting land use activities where they belong is just as essential as correcting existing deficiencies. Furthermore, by simultaneously displaying different types of information on the screen, local officals can see the impact of specific land use decisions, e.g. the effects of new development on transportation routes.

After the 1979 flood, the office began developing a systematic approach to disaster documentation. We wrote standards for taking aerial photographs at certain heights, and ground photos adjacent to historic watermarks and benchmarks. For every flood with a five-year frequency or greater, certain technical data and photographic evidence are collected. In addition, through cooperation with appropriate agencies, new gauges were installed and additional technical data such as the finished floor elevation of structures, and the size of crucial drainage openings were gathered. The data will eventually be incorporated into the computerized format.

We are seeking several small structural flood hazard mitigation projects from the Army Corps of Engineers. The close working relationship between our office and possible funding sources is one result of the door-to-door survey work administered entirely, or in part, by civil defense personnel for these funding agencies. Much of the manpower for these activities is provided by local colleges and universities.

LAND USE REGULATION PROPOSED

The very notion of regulating private land development is foreign to the political realities of our region. The prevailing attitudes can be changed only when we are able to depict the unique land use problems posed by flooding, on a site by site [illegible] done in this project was reported to the Association of American Geographers earlier this year. Computer output, photographs and [illegible] of the report were also exhibited during the Natural Hazards Research Workshop in Boulder, Colorado in July.

A number of ongoing projects are currently in progress under the supervision of the Columbus-Lowndes Civil Defense Council. These activities are, in part, responses to a major flood which took place in the spring of 1979. One study indicated that local residents prevented almost $2 million in property damage through actions taken prior to the flood.

Following the flood, a project was proposed to initiate nonstructural flood mitigation measures for a low- and moderate-income neighborhood located in a flood plain within the city of Columbus. In support of this project, the Civil Defense Office conducted a neighborhood survey, drafted a project narrative, and coordinated the preparation of the environmental review documents. Earlier this year the project was awarded over $300,000 under the Department of Housing and Urban Development's 407 program.

PUBLIC EDUCATION NEEDED

A local flood information repository, which will use micro- and minicomputers, microfilm, videotape and a manual filing arrangement should soon become a vital part of the program. These resources will be kept in a "war room" designed for use by persons interested in flood information. Not only will this facility be useful for research for project-oriented decisions, it will also show the nature and extent of local flood problems. The repository is the first major step to increase public awareness. An information booklet has already been distributed to flood plain residents.

The burden of proof rests with local government to convince the public that action is needed. Unless it can be shown that there is a serious problem and that the measures proposed are the best options available, little meaningful, long range action will be carried out.

The suggestion that sweeping land use policies and other local actions are needed to correct massive land use problems is consistently faced with the same cynicism that is usually used to attack federally inspired land use regulation programs. A meaningful countywide program must transcend these stereotypes and do more than merely "sell" somebody else's idea. Each community must consider flood related issues for itself. Several open ended questions confront communities searching for ways to reduce flood damage: Is there anything which could be done cost-effectively? Is the problem really of sufficient magnitude to justify full scale local investigation? The answers will vary from one county to the next.

LOCAL INITIATIVE ESSENTIAL

Urban counties, which want to evaluate flood insurance maps independently, as encouraged under the FIA program, often have difficulty finding the technical expertise to discuss specifics with study contractors and government officials. Existing flood plain maps and technical information, such as flood flow frequency curves, unit hydrographs and rainfall-runoff relations tend to go unquestioned unless a local effort is made to examine the information and the techniques used in preparing it. And yet, these materials have a direct bearing on the results of flood plain management programs. Only communities with dire flood problems are willing to make the effort required to establish their own flood preparedness programs.

It remains to be seen if such an intensive approach to local flood management planning can justify the time and resources it requires. However, the hazard mitigation approach to disaster preparedness brings the civil defense director/emergency management coordinator one step closer to the rest of the planning profession.

In the end, flood damage reduction becomes a planning issue, and a land use issue, because the willingness of communities to take appropriate remedial flood plain actions depends on the nature of their unique flood problems.

Ironically, Lowndes County residents voted last fall to withdraw from the National Flood Insurance Program. While this has resulted in the loss of federal support for countywide mitigation activities, it has also created a rather intensive forum for local dialogue. The net effect of withdrawal has been to restruct further flood plain development. Although existing developments are not covered by flood insurance, non-participation in this case becomes a valuable land use tool to redirect local property investments. It has also increased the county's incentive to demonstrate that a flood control program does, indeed, provide essential social benefits that aid the economic prosperity of the entire community. This, of course, is not an easy task. County residents will vote again this fall on whether to rejoin the NFIP.

HAZARD MITIGATION IS LAND USE ORIENTED

By regulating hazard mitigation planning activities to civil defense, an existing entity of county government, Lowndes County has provided a more service oriented, day-to-day role for the civil defense office.

Planning for natural disasters is inexorably tied to land use planning. Both must be treated systematically if county government is to assume the role of full partner in federally initiated natural disaster programs. Hazard mitigation is an inherent part of the decision-making process. However, the rationale for making expenditures that have long range damage reduction benefits must be clearly demonstrated. Traditional planning tools and techniques are best suited for this purpose.

In a number of states, including Mississippi, the Federal Insurance Administration (FIA), a FEMA agency, is preparing to provide financial support for flood hazard mitigation planning projects through its State Assistance Program. In most states this program is administered by a planning agency responsible for proliferating the National Flood Insurance Program.

FIA's apparent decision to deal with traditional planning and regulatory agencies rather than state emergency management agencies poses new challenges for county disaster preparedness programs. County emergency management agencies must attract qualified planners with professional training who can work with these planning agencies to cope with changes in federal programs.

The primary responsibility of the hazard mitigation coordinator is to draw from the complex interactions occurring over flood plain issues all the resources required to produce a viable plan. Technical information can and should be reduced to "the meat and potatoes," that county officials need to make their decisions.

No matter how credible the opinions of outside experts may appear, there is no substitute for firsthand, in-depth knowledge of local flood problems. A medium sized county with limited resources can deal with highly technical issues like flood plain management and can recognize that it can implement its findings.

The exercise becomes a labor of love, rather than just another government function. In the 1980s, county officials must develop local resources to deal with the facts in a professional, meaningful way.

Successful flood hazard mitigation is not so much what a county does about its flood related problems — it's a matter of how effectively it uses its resources to provide answers and alternatives.

APPENDIX II

ENVIRONMENTAL IMPACT MODELING
FOR
HIGHWAY CORRIDORS

by

W. Frank Miller, Director

The Mississippi Remote Sensing Center

P. O. Drawer FD
Mississippi State, MS 39762

TABLE OF CONTENTS

	Page
TABLE OF CONTENTS	i
LIST OF TABLES AND FIGURES	ii
INTRODUCTION	1
PROCEDURE	3
RESULTS AND DISCUSSION	4
CONCLUSIONS	15
APPENDICES:	
APPENDIX I	16

LIST OF TABLES AND FIGURES

		Page
Table 1.	Highway 78 Bypass Data Base Variables---------	5
Table 2.	Suitability Model for Route Impact, Highway 78 Bypass--	11
Figure 1.	Hand-held, color infrared 35 mm imagery of the study area. Looking north from Nita Lake.--	9
Figure 2.	Archeological sites identified in the study area.--	10
Figure 3.	An environmental impact model of a portion of the Highway 78 Bypass area.-------------------	14

ENVIRONMENTAL IMPACT MODELING FOR HIGHWAY CORRIDORS

Design of highways across wetlands has become a critical issue in Mississippi. In December of 1972, the Mississippi Highway Department (MHD) held a public hearing on a proposed relocation route for U.S. Highway 78 near Tremont, Mississippi. An environmental impact statement (EIS) was filed with the Council on Environmental Quality in August, 1974, and location approval was granted by the Federal Highway Administration (FHA) in July, 1975. A centerline location and design plan was developed for the proposed route; during this period, however, there was growing interest in wetlands conservation. With the issuance and individual interpretation of the Corps of Engineers (COE), the Environmental Protection Agency (EPA) and the U. S. Fish and Wildlife Service (FWS) wetlands regulations, plus Executive Order 11990, the interest in conservation essentially became an interest in preservation.

In March, 1979, an inspection of the proposed highway location by representatives of the MHD, COE, and the Federal Highway Administration revealed extensive wetlands impact in several sections of the proposed route. As a result, the MHD is attempting to define a practical alternative within the highway corridor that would minimize wetlands loss and be consistent with other environmental, economic and engineering constraints. Consultation between employees of The Mississippi Remote Sensing Center (MRSC) and the Environmental Division of the MHD resulted in a cooperative project to address the problem.

The objective of this study was to develop an information system based on remotely sensed data, soils, and topographic information which can be utilized to quantify environmental impacts of alternative highway routes within a corridor.

An interactive data base and modeling software system (CALUP*) had been developed by the staff of the MRSC in conjunction with another project. This system was selected as the vehicle for inventory and analysis of the environmental parameters of the study area. The system was selected because it has:

1) data-input flexibility, i.e., line or point data from any source at any scale be digitized and input to the data base at a given resolution;

2) easy data update capability, i.e., data variables such as land cover can be periodically updated with a minimum of effort and time;

3) an interactive capability for modeling, i.e., the operator can "model" the interaction of two to 10 or 12 variables stored in the data base in a real-time mode.

One of the most important facets of the CALUP package is the <u>modeling</u> capability. A model is defined as the interaction between data base variables which represents the suitability of a land area for the proposed use. There are two components of suitability - vulnerability and attractiveness. The vulnerability component attempts to quantify the vulnerability of the land area to the proposed use. For example, if oxbows and beaver ponds are "fragile" wetlands sites, then highway construction would have a profound deletorious impact, and the sites would be excluded from consideration. The attractiveness component attempts to quantify the desirability of the land area in terms of environmental,

*Computer Assisted Land Use Planning

aesthetic, or financial parameters. In the case of highway construction, lower slope percentage classes are financially more attractive than the 17 - 45% class. The actual development of a model will be demonstrated in a later section of this paper.

PROCEDURE

At the request of MHD personnel, an interdisciplinary team was drawn from the facility of Mississippi State University to explore the problem of developing an informative system for use in impact modeling. The team consisted of representatives from the following departments of the University: Agricultural and Biological Engineering, Civil Engineering, Wildlife and Fisheries, Biological Sciences, Agronomy Soils, and Forestry, The first task of the team was to define those environmental parameters which would be of major importance in defining suitability of wetland sites for highway construction. The team initially made a decision that detailed engineering criteria could not be considered in the modeling efforts, and that the system should serve only as a survey tool with major emphasis on assessment of environmental impacts. Whether or not the decision to exclude engineering criteria was a correct decision remains to be validated. In order to obtain the data resolution necessary for a detailed analysis, a cell size of 150 ft X 150 ft (0.52 ac) was selected by the team. The team concluded their initial meeting by drafting a disclaimer to the effect that the treatment of the problem is designed for large area assessment; although the actual study area in this project is small, the techniques developed will be suitable for use with synoptic, temporal satellite data.

A data acquisition phase was initiated and the MRSC staff contacted the following agencies for the items indicated:

1) EROS Data Center, Sioux Falls, SD - a 4x enlargement of a NASA Mission 192 frame (36-0146) obtained during January, 1972 with an enlargement scale of 1/12,500 or 1042 ft/in, land cover information;

2) Soil Conservation Service, Jackson, MS - advance soil survey sheets of the study area (the County Soil Survey has since been published);

3) MRSC - a low altitude flight with a hand-held 35mm camera, color infrared film, to obtain vegetative cover updates;

4) Department of Geology, MSU - information on gravel deposits and other mineral deposits in the study area;

5) Division of Historic Preservation, Dept. of Archives and History, Jackson, MS - locations of archeological or historic sites in the study area.

6) Neely Blueprint Co., Jackson, MS - 4x enlargement of the appropriate 7¼ min. U.S.G.S. topographic quadrangle sheets.

The variables selected by the interdisciplinary team were digitized into the data base by means of a Numonics Graphics Calculator which converts line or point data to X and Y coordinates. The orgin of the data base was the southwest corner of the study area.

After the data base was completed, the team met again and developed a preliminary model. This preliminary product was modified on two occasions before it was accepted by the team.

RESULTS AND DISCUSSION

The major result of the first meeting of the MSU interdisciplinary team was the compilation of a list of variables to be included in the data base. The selection of the variables was based upon the team's evaluation of what information would be required to successfully model the study area to determine impacts of alternative routes for the highway across the Bull Mountain Creek alluvial plain. Major variables selected were surface water, elevation, cultural features, soils, land cover classes, and forest stand composition. MRSC personnel further developed the variable classes and added subvariable classes as follows:

Table 1

Highway 78 Bypass Data Base Variables

Variable 1 Surface Water			Variable 2 (Elevation)		
Subvariable	0	None	Subvariable	0	300*
	1	1st order stream		1	310
	2	2nd order stream		2	320
	3	3rd order stream		3	330
	4	Ox-bow lakes		4	340
	5	Farm Ponds		5	350
	6	Lakes		6	400
	7	Void		7	450
	8	Void		8	500
	9	Void		9	550
	10	Void		10	Void
	11	Void		11	Void

Variable 3 Cultural/Transportation			Variable 4 Soils (Div. 1)		
Subvariable	0	None	Subvariable	0	Void
	1	Unimproved Road*		1	JE**
	2	Light duty road		2	JK
	3	Medium duty road		3	LPB
	4	Heavy duty road		4	LUC2
	5	Structures		5	LUD2
	6	Cemeteries		6	LUE
	7	Urban		7	MA
	8	Archeological		8	OAB2
	9	Void		9	OAC2
	10	Void		10	OAD2
	11	Void		11	PT

*from U.S.G.S. 7¼ mm quad sheet
**see Appendix I for legend and engineering properties

Table 1-Continued

Variable 5		Land Cover
Subvariable	0	Forest
	1	Pasture
	2	Mineral
	3	Wetland
	4	Row-crop
	5	Void
	6	Void
	7	Void
	8	Void
	9	Void
	10	Void
	11	Void

Variable 6		Forest Stand Composition
Subvariable	0	Void
	1	Upland hardwood
	2	Upland pine/hardwood
	3	Upland pine
	4	Bottomland hardwood
	5	Bottomland pine hardwood
	6	Bottomland pine
	7	Mixed Oak, Hickory, Sweetgum
	8	Swamp Tupelogum, Cypress
	9	Maple, Ash, Sugarberry
	10	Void
	11	Void

The MRSC personnel also perceived a need for proximity variables as follows:

Variable 7		Proximity to 2nd Order Streams
Subvariable	0	In cell
	1	1 cell away
	2	2 cells away
	3	3 cells away
	4	4 cells away
	5	5 cells away
	6	6 cells away
	7	7 cells away
	8	8 cells away
	9	9 cells away
	10	Void
	11	Void

Variable 8		Proximity to 3rd Order Streams
Subvariable	0	In cell
	1	1 cell away
	2	2 cells away
	3	3 cells away
	4	4 cells away
	5	5 cells away
	6	6 cells away
	7	7 cells away
	8	8 cells away
	9	9 cells away
	10	Void
	11	Void

44

Table 1-Continued

Variable 9 Proximity to Ox-Bow Lakes

Subvariable		
	0	In cell
	1	1 cell away
	2	2 cells away
	3	3 cells away
	4	4 cells away
	5	5 cells away
	6	6 cells away
	7	7 cells away
	8	8 cells away
	9	9 cells away
	10	10 Void
	11	11 Void

Variable 10 Proximity to Wetlands, Bottomland hardwood, Mixed oak, Swamp Tupelogum Cypress

Subvariable		
	0	In cell
	1	1 cell away
	2	2 cells away
	3	3 cells away
	4	4 cells away
	5	5 cells away
	6	6 cells away
	7	7 cells away
	8	8 cells away
	9	9 cells away
	10	10 cells away
	11	11 Void

Variable 11 Proximity to Row-Crops

Subvariable		
	0	In cell
	1	1 cell away
	2	2 cells away
	3	3 cells away
	4	4 cells away
	5	5 cells away
	6	6 cells away
	7	7 cells away
	8	8 cells away
	9	9 cells away
	10	Void
	11	Void

Variable 12 Proximity to Prime Farmland

Subvariable		
	0	In cell
	1	1 cell away
	2	2 cells away
	3	3 cells away
	4	4 cells away
	5	5 cells away
	6	6 cells away
	7	7 cells away
	8	8 cells away
	9	9 cells away
	10	Void
	11	Void

Table 1 - Continued

Variable 13 Soils (Div. 2)

Subvariable		
	0	Void
	1	SBA*
	2	SBB
	3	SDC2
	4	SDE
	5	SMF
	6	STF
	7	Void
	8	Void
	9	Void
	10	Void
	11	Void

Variable 14 Proximity to Row Crops in Prime Farmland

Subvariable		
	0	In Cell
	1	1 cell away
	2	2 cells away
	3	3 cells away
	4	4 cells away
	5	5 cells away
	6	6 cells away
	7	7 cells away
	8	8 cells away
	9	9 cells away
	10	Void
	11	Void

The proximity variables can be utilized in two ways; to keep the activity a specified distance from a feature, or to maintain the activity within a given distance of the features. For example, the team felt that a highway should be located no closer than 2 cells (300 ft) from an oxbow, and this information was input to the model.

Due to the small size of the corridor, approximately 8.6 sq. mi, aircraft imagery was utilized for land cover identifications; the system will, however, accept classified Landsat digital data. A low altitude flight was made to obtain imagery (Fig. 1) with which to update the older NASA imagery Land cover and forest types were mapped on the 1972 imagery, and verified by reference to the 1979 imagery. Two archeological sites were reported by the Mississippi Department of Archives and History. One site (Fig. 2) is a confirmed site, but the "B" site was reported by an amateur archeologist and has not been confirmed (Fig. 2). Both sites, however, were excluded from consideration.

*see Appendix I for legend and engineering properties.

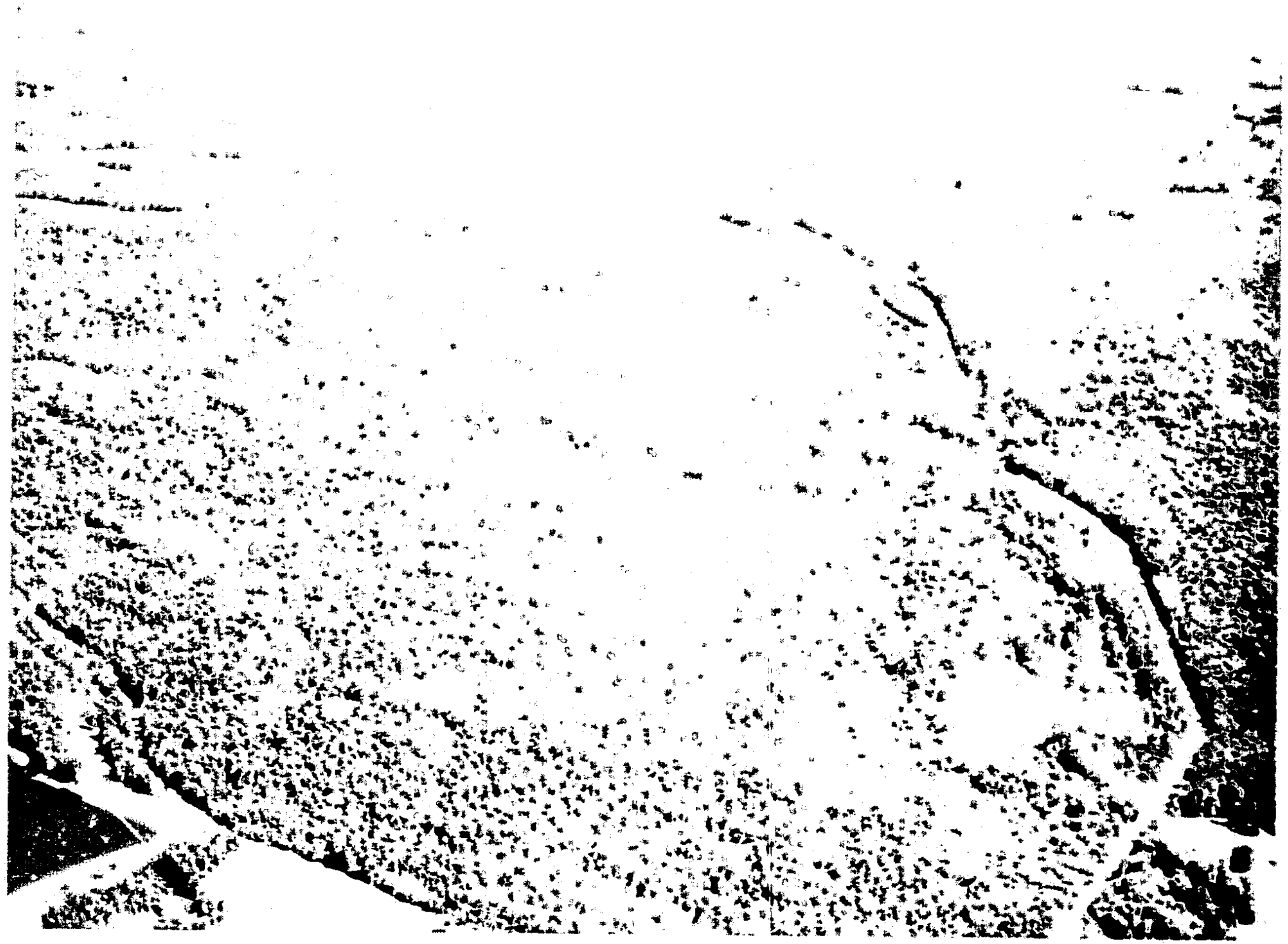

Figure 1. Hand-held, color infrared 35 mm imagery of the study area. Looking north from Nita Lake.

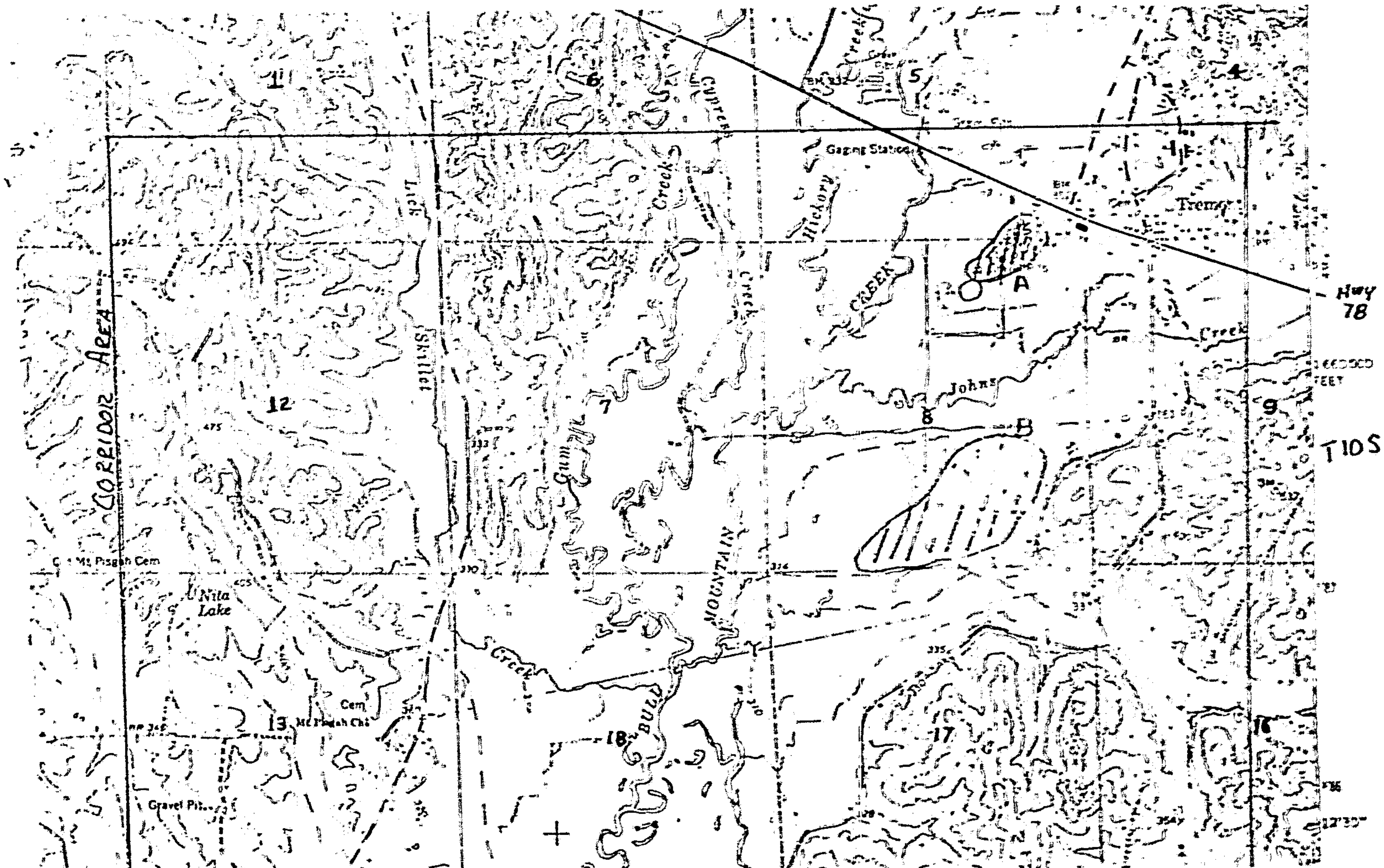

Figure 2. Archeological sites identified in the study area. Site A is confirmed and does not appear on the model; Site B is unconfirmed.

48

Table 2

Suitability Model for Route Impact, Highway 78 Bypass

SUITABILITY INDEX EVALUATION FORM

Suitability Index Name Route Impact

Study Highway 78

Date December 1979

Variable No.	0	1	2	3	4	5	6	7	8	9	Weight	Weight Per Cent
Surface Water	9	1	2	5	0	7	0	0	0	0	10	12.50
Cult./ Transp.	9	9	9	9	9	2	2	1	0	0	10	12.50
Soils - Div. 1	9	2	2	9	8	7	3	3	9	8	15	18.75
Soils - Div. 2	9	9	9	8	7	4	4	0	0	0		
For. Stand Composition	9	7	8	8	2	5	7	3	1	4	15	18.75
Pr. Wetlands	1	2	6	9	9	9	9	9	9	9	5	6.25
Land Cover	7	9	6	2	8	0	0	0	0	0	10	12.50
Pr. 2nd Order St.	1	2	9	9	9	9	9	9	9	9	5	6.25
Elevation	5	5	7	9	9	9	7	7	7	7	5	6.25
Pr. Oxbows	2	4	9	9	9	9	9	9	9	9	5	6.25

Rate each value for each variable from 1 (low) to 9 (high).

To reject a cell on a particular condition, code a 0 under those particular variable values.

Weight – relative contribution of each variable to attractiveness or vulnerability

Upon completion of variable input to the data base, the MSU interdisciplinary team met again to develop a model. The process of model development is sometimes a long and somewhat painful process, and is best accomplished by informing the participants that no one can leave the room until agreement is reached between the diverse veiwpoints represented. The objective of this exercise is to 1) arrive at a listing of variables which are considered to be most critical in terms of their contribution to either the vulnerability or attractiveness of land area (cell) for the proposed use; 2) assign weights both to the variables relative to each other, and to the subvariables within variables. The first step is relatively easy to accomplish; up to 14 variables can be accomodated, and thus almost everyone has an opportunity to input the variables they consider to be most important. Even the weighting of variables relative to each other is fairly easy. However, the major problem arises in ranking the subvariables on a 0 (excluded) or 1 (lowest suitability) to 9 (highest suitability) basis. This part of the exercise requires a great deal of negotiation until all discipline representatives are satisfied.

Several preliminary models were run and the computer output examined. Modifications were made in some of the weights and the variables used before a model acceptable to all members of the team was produced (Table 2). Examination of the column designated as "Weight" in Table 2 indicates that the team believed Soils and Forest Stand Composition (Var. 6) were most important, and assigned them each a weight of 15. The next column, "Weight Percent" indicates this relative contribution of each to the total suitability, i.e., the three apparently contribute a total of 37.5% of the suitability. Surface Water (Var. 1) Cultural/Transportation (Var. 3) and Land Cover (Var. 5) each contributed 12.5% of the total suitability. The five variables together thus accounted for approximately 75% of the route suitability. The variables can be weighed on any scale selected, i.e., 1 - 10, or multiples of any sequence such as 2, 4, or 5's such as the model indicates. Weighting subvariables is accomplished in a similar fashion. A 9 rating is assigned to the most suitable subvariable, a 0 to excluded categories, and 1 through 8 to intermediate categories. Surface Water, for example, was subdivided and ranked as follows: in cell (9), first order (1), second order (2), third order (3), oxbow lake (0), ponds (7), and lakes (0). A cell with no surface water was most desirable and thus was ranked as 9. First and second order streams were highly undesirable and were ranked as 1 and 2, respectively, while lakes and oxbows were excluded. Small bodies of water such as farm ponds were not considered to present engineering or foundation problems if drained, and were correspondingly ranked as 7.

The hardcopy computer output of this model is illustrated in Figure 3; dark areas indicate high suitability 8, 9 , and therefore low impact; an integrated rating of 7 is indicated by Θ, 6 by 0, 5 by O, 4 by X, and blank areas are excluded. The suitability of alternative routes can be compared by summing the rating values of the cells included in each right-of-way, and dividing the sum by (9 X no. cells).

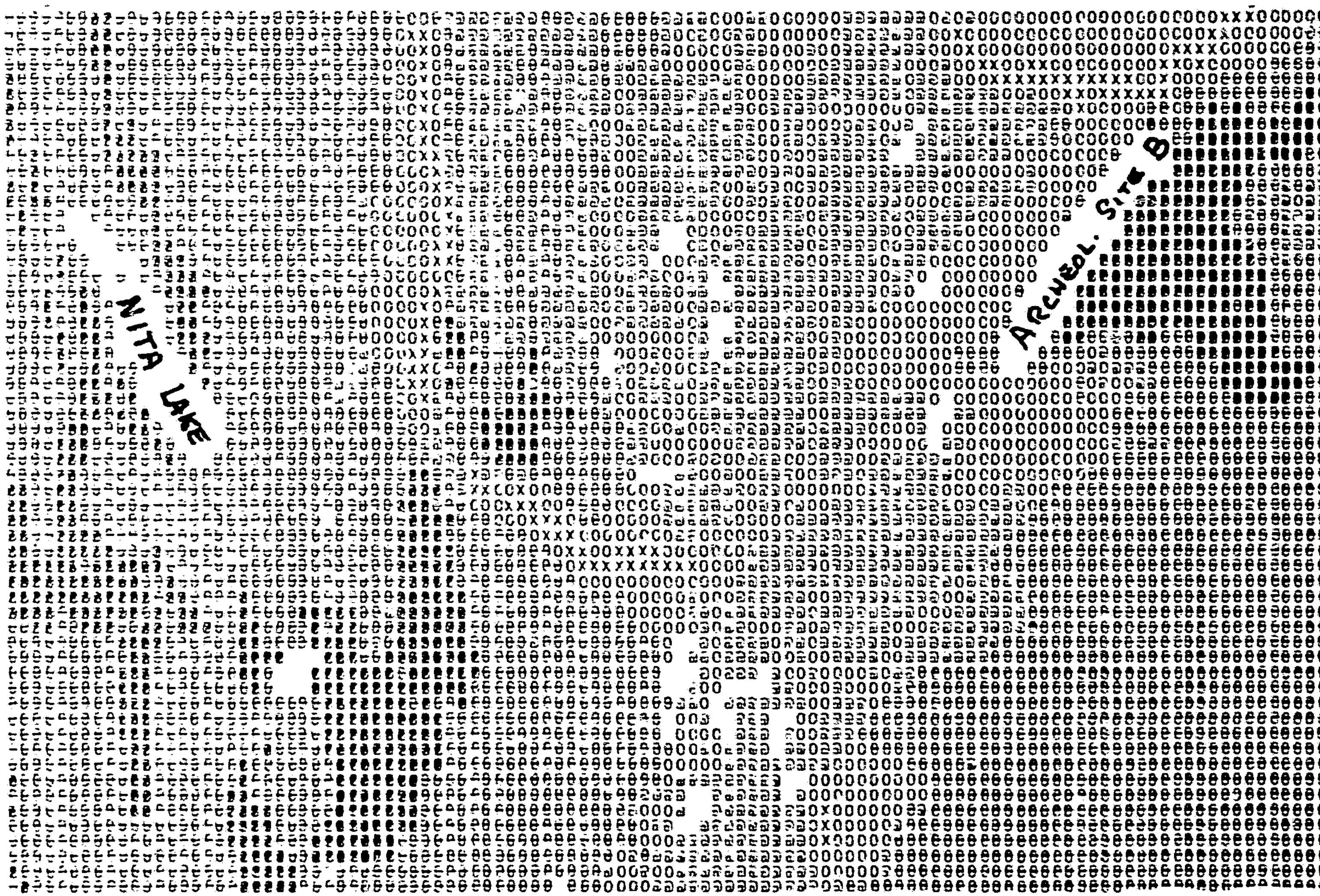

Figure 3. An environmental impact model of a portion of the Highway 78 Bypass area; darker tones indicate low impact, lighter area high impact, and white areas are excluded (lakes, oxbows, archeological sites).

52

CONCLUSIONS

The methodology developed in this study constitutes a cost-effective means of assessing environmental impacts of alternative highway routes. It's greatest utility would be in assessing alternative corridors, but it has applicability in assessing alternative routes within a given corridor. To further improve the utility of the methodology, a re-examination of the feasibility of adding engineering variables should be made. It is virtually certain, however, that the integration of engineering variables will entail a limited amount of software modification, and research and development funds should be made available for the task.

The MRSC is amenable to either a transfer of technology to the MHD, or to acting in a service role by contracting specific projects with the MHD. If the service role is contemplated, most or all of the data collection and digitizing could be accomplished by the Photogrammetric Division of the MHD.

It must be understood that the methodology produces only a generalized survey or guide to alternative route locations. The technique is, in no manner, intended to be of an accuracy suitable to replace field surveys of potential routes.

APPENDIX I

SOIL MAPPING UNIT KEY

SYMBOL	
JE	Jena loam
JK	Jena-Kirkville association 1/
LPB	Lexington silt loam, 2 to 5 percent slopes, eroded
LUC2	Luverne fine sandy loam, 5 to 8 percent slopes, eroded
LUD2	Luverne fine sandy loam, 8 to 12 percent slopes, eroded
LUE	Luverne fine sandy loam, 12 to 25 percent slopes
MA	Mantachie loam
OAB2	Ora fine sandy loam, 2 to 5 percent slopes, eroded
OAC2	Ora fine sandy loam, 5 to 8 percent slopes, eroded
OAD2	Ora fine sandy loam, 8 to 12 percent slopes, eroded
PT	Pits
SBA	Savannah loam, 0 to 2 percent slopes
SBB	Savannah loam, 2 to 5 percent slopes
SDC2	Smithdale fine sandy loam, 5 to 8 percent slopes, eroded
SDE	Smithdale fine sandy loam, 8 to 17 percent slopes
SMF	Smithdale association, hilly 1/
STF	Smithdale-Luverne association, hilly 1/

1/ The composition of these units is more variable than that of others in the survey area, but has been controlled well enough to be interpreted for the expected use of the soils.

ENGINEERING PROPERTIES OF SOIL MAPPING UNITS

SYMBOL	ROADFILL	ROAD CONSTRUCTION LIMITATIONS
JE	Fair: low strength	Severe: floods
JK	Fair: low strength	Severe: floods
LPB	Fair: low strength	Moderate: low strength
LUC2	Fair: too clayey	Severe: low strength
LUD2	Fair: too clayey	Severe: low strength
LUE	Poor: too clayey, slope	Severe: low strength slope
MA	Fair: wetness, low strength	Severe: floods
OAB2	Fair: low strength	Moderate: low strength
OAC2	Fair: low strength	Moderate: low strength
OAD2	Fair: low strength	Moderate: low strength
PT		
SBA	Good	Moderate: low strength
SBB	Fair: low strength	Moderate: low strength
SDC2	Fair: low strength	Slight
SDE	Good	Moderate: slope
SMF	Poor: slope	Severe: slope
STF	Poor: slope	Severe: slope

APPENDIX III

DEPARTMENT OF THE ARMY

MOBILE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 2288
MOBILE, ALABAMA 36628

REPLY TO
ATTENTION OF:
SAMOP-S

18 July 1980

Professor Frank Miller
Mississippi State University
School of Forestry
P. O. Drawer FD
Mississippi State, Mississippi 39762

Dear Professor Miller:

One of the problems facing the regulatory functions mission of the Corps is getting a handle on how to deal with assessments of cumulative impacts upon wetlands.

Development of computer techniques to accomplish this task would have wide application to the program. Let me encourage you to continue with your efforts.

Sincerely yours,

D. M. CONLON
Chief, Regulatory Functions Branch
Operations Division

DEPARTMENT OF THE ARMY
MOBILE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 2288
MOBILE, ALABAMA 36628

REPLY TO
ATTENTION OF:
SAMOP-S

5 September 1980

Dr. W. Frank Miller, Director
Mississippi Remote Sensing Center
Department of Forestry
P. O. Drawer FD
Mississippi State, MS 39762

Dear Dr. Miller:

In reference to your letter of 17 July 1980 to Mr. Don Conlon, I have been asked by Mr. Conlon to respond to your requests. The Mobile District has several concerns which deal with different aspects of freshwater wetlands. In response to your first request, one area of major concern is:

1. Delineation of wetlands for a specific project, using aerial photography of a detail to be useful for 404 permit uses.

2. Identification of the specific type or types of wetlands delineated. Since several agencies have adopted the Fish and Wildlife Service's Classification of Wetlands and Deepwater Habitats of the United States, December 1979, this task, though difficult and time consuming, at least has resulted in a uniform system of wetland classification.

3. Identification and delineation of wetland types within a large geographical area, such as the coastal counties of Mississippi and Alabama. This is currently being done by the Coastal Ecosystem Team of the Fish and Wildlife Service.

In reference to our needs with respect to freshwater wetland classification, inventory and monitoring, etc.: In the Section 404 Regulatory Functions Program of the Corps of Engineers, decisions must be made as to whether or not the area is a wetland and if it is a wetland, would it fall within the jurisdiction of the 404 program. If the area is a jurisdictional wetland, the Corps Regulations require that decisions relative to the wetland be based on very precise identification and delineation of the wetlands located on the project site. We have not been able to find an alternative to an on-site inspection which would allow us to make these required decisions.

I hope this information satisfactorily answers your concerns.

Sincerely yours,

Davis Findley

DAVIS FINDLEY
Chief, Technical Unit
Regulatory Functions Branch